VEGETATION CLASSIFICATION AND SURVEY

International Association for Vegetation Science (IAVS)

Vegetation Classification and Survey 5: 11–15
doi: 10.3897/VCS.103154

NOMENCLATURAL PROPOSAL PHYTOSOCIOLOGICAL NOMENCLATURE

Proposal (36) to conserve the name *Philonotidion seriatae* Hinterlang 1992 for the species-poor, bryophyte-dominated, non-calcareous arctic-alpine spring vegetation of Europe

Michal Hájek[1], Tomáš Peterka[1], Petra Hájková[1,2], Dirk Hinterlang[3], Harald Zechmeister[4], Milan Chytrý[1]

1 *Department of Botany and Zoology, Faculty of Science, Masaryk University, Brno, Czech Republic*
2 *Department of Paleoecology, Institute of Botany, Czech Academy of Sciences, Brno, Czech Republic*
3 *Landesamt für Natur, Umwelt und Verbraucherschutz NRW, Recklinghausen, Germany*
4 *Division Biodiversity Dynamics and Conservation, Department of Botany and Biodiversity Research, University of Vienna, Vienna, Austria*

Corresponding author: Michal Hájek (hajek@sci.muni.cz)

Academic editor: Wolfgang Willner ♦ **Linguistic editor:** Hallie Seiler
Received 7 March 2023 ♦ **Accepted** 19 January 2024 ♦ **Published** 1 March 2024

Abstract

According to the International Code of Phytosociological Nomenclature, a younger name of a syntaxon may be conserved against its older name to improve the stability of the nomenclature and avoid misunderstandings in scientific communication. Here, we propose conserving the name *Philonotidion seriatae* Hinterlang 1992 for arctic-alpine, bryophyte-dominated, non-calcareous spring vegetation against the names *Cardamino-Montion* Braun-Blanquet 1925, *Cardamino-Montion* Braun-Blanquet 1926, and *Montion* Maas 1959. In current vegetation classification systems, the two name-giving taxa of *Cardamino-Montion* no longer indicate the character of the vegetation corresponding to the nomenclatural type of this alliance and are instead characteristic of other currently distinguished alliances. Maintaining the oldest name *Cardamino-Montion* in strict adherence to the Code would be a source of errors. In the current vegetation classification systems, two similar but counter-intuitive names would then have to be used: *Cardamino-Montion* for arctic-alpine springs (although the name-giving taxa are more indicative of montane springs) and *Epilobio nutantis-Montion* for montane springs (although the name-giving taxon *Epilobium nutans* is indicative of arctic-alpine vegetation). Hence, there is a risk that the name *Cardamino-Montion* may gradually become ambiguous. We also propose conserving the name *Philonotidion seriatae* against *Mniobryo-Epilobion hornemannii* Nordhagen 1943 to prevent confusion in case of a merger of these alliances.

(36) *Philonotidion seriatae* Hinterlang 1992
Typus: *Cratoneuro-Philonotidetum* Geissler 1976 (holotypus)

(=) *Cardamino-Montion* Braun-Blanquet 1925
Typus: *Bryetum schleicheri* Braun-Blanquet 1925 [≡ *Montio fontanae-Bryetum schleicheri* Braun-Blanquet 1925 nom. corr. et invers. (alternative name)] (holotypus)

(=) *Cardamino-Montion* Braun-Blanquet 1926 nom. superfl. [≡ *Cardamino-Montion* Braun-Blanquet 1925]

(=) *Mniobryo-Epilobion hornemannii* Nordhagen 1943
Typus: *Mniobryo-Epilobietum hornemannii* Nordhagen 1943 (lectotypus selected by Zechmeister & Mucina 1994)

(=) *Montion* Maas 1959 nom. superfl. [≡ *Cardamino-Montion* Braun-Blanquet 1925]

Taxonomic reference: Euro+Med PlantBase (http://europlusmed.org; accessed 4 January 2024)

PENSOFT

Copyright *Michal Hájek et al.* This is an open access article distributed under the terms of the Creative Commons Attribution License (CC-BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Keywords

Cardamino-Montion, *Montio-Cardaminetea*, *nomen conservandum*, phytosociological nomenclature, springs

The syntaxonomic classification of non-calcareous spring vegetation in Europe has evolved from the concept of a single alliance, *Cardamino-Montion*, to the concept of ecologically and floristically more homogeneous units. This may lead to the misuse of some old names.

Cardamino-Montion Braun-Blanquet 1925 is the oldest alliance name for spring vegetation in Europe. The holotype of this name is the association *Bryetum schleicheri*, published on page 128 in Braun-Blanquet (1925), which is the only element published under the alliance name in the table on page 129. In this table, the alternative name "Assoziation von *Bryum Schleicheri* und *Montia rivularis*" (recte: *Montio fontanae-Bryetum schleicheri* Braun-Blanquet 1925 nom. corr. et invers.) is used for the same association. The latter name must be corrected (Art. 44; Theurillat et al. 2021) because *Montia rivularis* is a younger synonym of *M. fontana* (see the Euro+Med PlantBase). Moreover, as *Bryum schleicheri* has a higher cover than *Montia fontana* in 6 out of 7 relevés (and equal cover in the remaining one), the name must also be inverted (Art. 42). The lectotype of the association, selected by Hinterlang (2017), is relevé 2 in Table 1 of the Braun-Blanquet article (1925).

The association *Bryetum schleicheri* Braun-Blanquet 1925 represents the vegetation of open subalpine springs on non-calcareous bedrock. Its relevés were sampled at high elevations (1350–1610 m a.s.l.) in the Massif Central, as specified in a subsequent article (Braun-Blanquet 1926). *Bryum schleicheri* (*Ptychostomum schleicheri* in the Euro+Med PlantBase), the dominant taxon in the original diagnosis (Braun-Blanquet 1925, 1926), is a circumpolar species with an arctic-alpine distribution. *Saxifraga stellaris*, another predominantly arctic-alpine species that only rarely descends to the montane belt, is the second most abundant species listed among the faithful (*treue*) character species. *Sagina linnaei* (*S. saginoides*) and *Epilobium nutans* are listed as two other faithful character species with optimum distribution in arctic-alpine areas. The arctic-alpine character of the *Bryetum schleicheri* association (Braun-Blanquet 1925, 1926) is further underlined by the firm (*feste*) character species *Philonotis seriata*, which co-dominated the moss layer. *Montia fontana*, reported as a firm (*feste*) character species, occurred in all seven relevés, but with low abundance (+ in five cases; 1 in two cases). In contrast to the other species mentioned, this taxon has its distributional optimum at lower elevations, where it often dominates, whereas it only rarely occurs in vegetation where arctic-alpine taxa prevail. Besides the type association, Braun-Blanquet (1926) included within the alliance the association *Cardaminetum amarae subatlanticum*, which was documented with only one relevé, again from the high elevations of the Massif Central (Mt Puy Mary, 1350 m a.s.l.).

As knowledge of the variability of non-calcareous spring vegetation in Europe increased, new alliances were identified. Nordhagen (1943) described the *Mniobryo-Epilobion hornemannii* alliance, another bryophyte-dominated non-calcareous vegetation with many similarities to *Bryetum schleicheri* (e.g. the dominance of *Philonotis seriata* and *Saxifraga stellaris*).

Maas (1959) divided Braun-Blanquet´s *Cardamino-Montion* into two alliances: *Cardaminion amarae* (shaded springs) and *Montion* (open springs). The latter is a superfluous name (Art. 29c), since its diagnosis contains the *Bryetum schleicheri* Braun-Blanquet "1926" (recte: 1925), which is the nomenclatural type of *Cardamino-Montion* Braun-Blanquet 1925. Shaded forest springs were then distinguished from non-forest springs at the alliance level in most subsequent vegetation surveys. Mucina et al. (2016) classified them as the *Caricion remotae* Kästner 1941 alliance (the oldest valid name).

Table 1. Literature survey showing the variable use of the name *Cardamino-Montion* with regard to shading and elevation.

(Sub)alpine non-calcareous springs	(Sub)alpine non-calcareous springs plus other types of spring vegetation	Low- and mid-elevation non-forest (unshaded) springs	Forest (shaded) springs
Braun-Blanquet (1926)	Bartsch and Bartsch (1940)	Büker (1942)	Tüxen (1937)
Zechmeister and Mucina (1994)	Oberdorfer (1957)	Lebrun et al. (1949)	Lebrun et al. (1949)
Bardat et al. (2004)	Dierßen (1996)	Maas (1959)	Soó (1949)
Tomaselli et al. (2011)	Coldea (1997)	Hadač (1983)	Rațiu et al. (1983)
Mucina et al. (2016)	Diekmann (1997)	Hinterlang (1992)	Siebum et al. (1995)
	Mertz (2000)	Siebum et al. (1995)	Laiviņš (1998)
	Rennwald et al. (2000)	Redžić (2007)	Passarge (1999)
	Oberdorfer (2001)	Ranđelović and Zlatković (2010)	Lawesson (2004)
	Rivas-Martínez et al. (2001)	Redžić et al. (2011)	Schaminée et al. (2017)
	Dierßen and Dierßen (2005)	Borhidi et al. (2012)	
	Matuszkiewicz (2007)	Schaminée et al. (2017)	
	Ellenberg and Leuschner (2010)		

The separation of spring vegetation with arctic-alpine species, dominated by mosses, from colline to montane spring vegetation, dominated by *Montia fontana* and other vascular plants, was introduced in the synthesis of Czechoslovak spring vegetation by Hadač (1983). He reported the *Cardamino-Montion* alliance from the montane zone in the westernmost part of Czechoslovakia, where the arctic-alpine character species of the type association do not occur. For the alpine zone, he described two new alliances: a productive, herb-dominated one (*Cratoneuro filicini-Calthion laetae* Hadač 1983) and a moss-rich one with low productivity, characterized by *Philonotis seriata* and *Diobelonella palustris* (syn.: *Anisothecium squarrosum*, *Dichodontium palustre*, *Dicranella palustris*). Due to obvious differences compared to the *Cardamino-Montion* (e.g., the presence of *Allium schoenoprasum*, *Bartsia alpina*, *Swertia perennis*, and *Pedicularis sudetic*a, and the absence of *Saxifraga stellaris*, *Sagina saginoides*, *Sedum villosum*, and *Montia fontana*), Hadač (1983) described this vegetation as *Swertio perennis-Anisothecion squarrosi* Hadač 1983.

Later, Hinterlang (1992) described another new alliance for bryophyte-dominated arctic-alpine spring vegetation, *Philonotidion seriatae*, which contains *Philonotis seriata*, *Bryum schleicheri* and *Saxifraga stellaris* as in Braun-Blanquet's original description of *Cardamino-Montion*. Nevertheless, he retained the name *Cardamino-Montion* for springs with *Montia fontana* s.l., including Braun-Blanquet´s subalpine association.

Consistent differentiation between bryophyte-dominated arctic-alpine spring vegetation and herb-rich montane spring vegetation with *Montia fontana* agg. began with the first Europe-wide synthesis of spring vegetation by Zechmeister and Mucina (1994). In this study, the vegetation of low-elevation (mostly colline and submontane) springs with *Montia fontana* was described as the new alliance *Epilobio nutantis-Montion* Zechmeister in Zechmeister et Mucina 1994. The same solution was adopted in many subsequent studies, and finally also in the European vegetation checklist by Mucina et al. (2016). The name *Philonotidion seriatae* Hinterlang 1992 was placed there, for unspecified reasons, as a synonym of *Swertio perennis-Anisothecion squarrosi* Hadač 1983 instead of *Cardamino-Montion*, with which it shares more diagnostic species.

Recently, Peterka et al. (2023) conducted a new pan-European synthesis of spring vegetation based on original relevé data classified using both unsupervised and supervised methods. This study identified vegetation types that consistently formed distinct clusters in numerical analyses (unsupervised classifications) and were reproducible by formal definitions (supervised classifications). In most cases, these vegetation types corresponded to each the above-mentioned alliances, with one exception: the relevés corresponding to the type associations of *Cardamino-Montion* and *Philonotidion seriatae* fell into one group in all cases, even when a fine classification with many clusters was performed. Peterka et al. (2023) selected the name *Philonotidion seriatae* Hinterlang 1992 for this vegetation, arguing that the name *Cardamino-Montion* was often used for different vegetation types in the past (herb-dominated colline to montane *Montia* springs and even shaded low-elevation springs), making it a source of misunderstanding among vegetation scientists and thus a *nomen ambiguum*.

Table 1 shows how the name *Cardamino-Montion* has been used for very different vegetation types corresponding to different currently distinguished alliances and even orders. Although it is not possible to prove that most of these uses excluded the type of this alliance, i.e. the open arctic-alpine vegetation of the *Bryo schleicheri-Montietum rivularis* association, it is obvious that different authors understand the name differently. Throughout the history of phytosociology, classification concepts evolved from a single broad alliance *Cardamino-Montion* towards smaller, ecologically and floristically more homogeneous units at the alliance level. The two name-giving taxa of *Cardamino-Montion*, both of which actually involve subordinate taxa with different ecological requirements, do not characterize the vegetation corresponding to the type and are instead characteristic of other currently distinguished alliances: *Cardamine amara* s.l. of *Caricion remotae* and *Cratoneuro-Calthion laetae*, and *Montia fontana* s.l. of *Epilobio nutantis-Montion*. Applying the rules strictly and maintaining the oldest name *Cardamino-Montion* would be a constant source of error. We would then have to use two similar, counter-intuitive names: *Cardamino-Montion* for arctic-alpine springs (although the name-giving taxa occur mainly in montane springs) and *Epilobio nutantis-Montion* for montane springs (although the name-giving taxon, *Epilobium nutans*, occurs mainly in arctic-alpine springs). Therefore, it is likely that the name *Cardamino-Montion* would gradually become ambiguous.

For these reasons, we propose conserving the name *Philonotidion seriatae* Hinterlang 1992 against the names *Cardamino-Montion* Braun-Blanquet 1925, *Cardamino-Montion* Braun-Blanquet 1926, and *Montion* Maas 1959. The latter three alliances share a nomenclatural type which is different from the type of *Philonotidion seriatae*. The type of *Philonotidion seriatae* is *Cratoneuro-Philonotidetum* Geissler 1976. The lectotype of this association, selected by Hinterlang (2017), is relevé 11 in table 10 in Geissler's article (1976).

In addition, we propose conserving the name *Philonotidion seriatae* Hinterlang 1992 against the name *Mniobryo-Epilobion hornemannii* Nordhagen 1943. This will prevent the name *Mniobryo-Epilobion hornemannii* Nordhagen 1943 from being used for a broader alliance containing the nomenclatural types of *Cardamino-Montion*, *Philonotidion seriatae*, and *Mniobryo-Epilobion hornemannii*, since *Epilobium hornemanii* does not occur in most of the distribution range of such a hypothetical alliance.

We acknowledge that classification systems combining associations to alliances differently than was done in the studies by Zechmeister and Mucina (1994), Mucina et al. (2016), and Peterka et al. (2023) may appear in the future. If our proposal is accepted, then the name *Philonotidion seriatae* Hinterlang 1992 should be used for all

species-poor, bryophyte-dominated, non-calcareous spring vegetation types. The name, however, would exclude *Cratoneuro filicini-Calthion laetae* Hadač 1983, which is productive, herb-dominated, and partly transitional to *Cardamino-Chrysosplenietalia* Hinterlang 1992 or even *Mulgedio-Aconitetea*. It would also exclude *Swertio perennis-Anisothecion squarrosi* Hadač 1983, which is also rich in herbs and partly transitional to *Scheuchzerio-Caricetea nigrae*. Any hypothetical alliance comprising the latter two herb-rich alliances should therefore be named either *Cratoneuro filicini-Calthion laetae* Hadač 1983 or *Swertio perennis-Anisothecion squarrosi* Hadač 1983, depending on its content. We consider these names more suitable for such hypothetical alliances than *Philonotidion seriatae*, as they both contain taxa from the highest vegetation stratum (herb layer in this case). Finally, a hypothetical alliance combining all non-calcareous springs (regardless of shading and climate, i.e. comprising two currently recognized orders) would be named *Caricion remotae* Kästner 1941.

Should our proposal be accepted, the name *Cardamino-Montion* would remain available for a hypothetical alliance that excludes the type of *Philonotidion seriatae*; e.g. an alliance comprising non-calcareous springs regardless of elevation, but excluding vegetation extremely poor in vascular plants or without *Montia fontana*.

Author contributions

M.H. led the writing, while all authors conceived the idea and critically revised the manuscript.

Acknowledgements

This proposal was prepared with the support of the Czech Science Foundation (project EXPRO CEVS no. 19-28491X). PH was partially supported by the long-term developmental project of the Czech Academy of Sciences (RVO 67985939). We are grateful to anonymous reviewers and the editors (W. Willner, H. Seiler) for valuable comments on earlier versions of the proposal.

References

Bardat J, Bioret F, Botineau M, Boullet V, Delpech R, Géhu J-M, Haury J, Lacoste A, Rameau J-C, … Touffet J (2004) Prodrome des végétations de France. Museum national d'histoire naturelle, Paris, FR.

Borhidi A, Kevey B, Lendvai G (2012) Plant communities of Hungary. Akadémiai Kiadó, Budapest, HU.

Braun-Blanquet J (1925) Zur Wertung der Gesellschaftstreue in der Pflanzensoziologie. Vierteljahrsschrift der Naturforschenden Gesellschaft in Zürich 70: 122–149.

Braun-Blanquet J (1926) Etudes phytosociologiques en Auvergne. Arvernia 2: 29–48.

Büker R (1942) Beiträge zur Vegetationskunde des südwestfälischen Berglandes. Beihefte zum Botanischen Centralblatt 56B: 452–558.

Coldea G (Ed.) (1997) Les associations végétales de Roumanie. Tome 1. Les associations herbacées naturelles. Presses Universitaires de Cluj, Cluj-Napoca, RO.

Diekmann M (1997) The differentiation of alliances in South Sweden. Folia Geobotanica 32: 193–205. https://doi.org/10.1007/BF02803740

Dierßen K (1996) Vegetation Nordeuropas. Ulmer, Stuttgart, DE.

Dierßen K, Dierßen B (2005) Studies on the vegetation of fens, springs and snow fields in West Greenland. Phytocoenologia 35: 849–885. https://doi.org/10.1127/0340-269X/2005/0035-0849

Ellenberg H, Leuschner C (2010) Vegetation Mitteleuropas mit den Alpen: in ökologischer, dynamischer und historischer Sicht. Ulmer, Stuttgart, DE.

Geissler P (1976) Zur Vegetation alpiner Fließgewässer. Pflanzensoziologisch-ökologische Untersuchungen hygrophiler Moosgesellschaften in den östlichen Schweizer Alpen. Beiträge zur Kryptogamenflora der Schweiz 14: 1–52.

Hadač E (1983) A survey of plant communities of springs and mountain brooks in Czechoslovakia. Folia Geobotanica et Phytotaxonomica 18: 339–361. https://doi.org/10.1007/BF02857260

Hinterlang D (1992) Vegetationsökologie der Weichwasserquellgesellschaften zentraleuropäischer Mittelgebirge. Crunoecia 1: 1–117.

Hinterlang D (2017) Synopsis der Pflanzengesellschaften Deutschlands, Heft 12: *Montio-Cardaminetea* (C6) Quell- und Waldsumpfgesellschaften. Floristisch-soziologische Arbeitsgemeinschaft, Göttingen, DE.

Laiviņš M (1998) Latvijas ziedaugu un paparžaugu sabiedrību augstākie sintaksoni. Acta Universitatis Latviensis 613: 7–22.

Lawesson JE (2004) A tentative annotated checklist of Danish syntaxa. Folia Geobotanica 39: 73–95. https://doi.org/10.1007/BF02803265

Lebrun J, Noirfalise A, Heinemann P, Vanden Berghen C (1949) Les associations végétales de Belgique. Bulletin de la Société Royale de Botanique de Belgique 82: 105–199.

Maas FM (1959) Bronnen, bronbeken en bronbossen van Nederland, in het bijzonder die van de Veluwezoom. Mededelingen van de Landbouwhogeschool Wageningen 59: 1–166.

Matuszkiewicz W (2007) Przewodnik do oznaczania zbiorowisk roślinnych Polski. Wydawnictwo Naukowe PWN, Warszawa, PL.

Mertz P (2000) Plant communities in Central Europe and the Alps. Recognition, determination, evaluation: a handbook for practical vegetation science. Ecomed Verlagsgesellschaft, Landsberg am Lech, DE.

Mucina L, Bültmann H, Dierssen K, Theurillat J-P, Raus T, Čarni A, Šumberová K, Willner W, Dengler J, … Tichý L (2016) Vegetation of Europe: hierarchical floristic classification system of vascular plant, bryophyte, lichen, and algal communities. Applied Vegetation Science 19(Suppl. 1): 3–264. https://doi.org/10.1111/avsc.12257

Nordhagen R (1943) Sikilsdalen og Norges fjellbeiter. En plantesosiologisk monografi [Sikilsdalen and Norwegian mountain pastures: a plant sociological monograph]. Bergens Museums Skrifter 22: 1–607.

Oberdorfer E (1957) Süddeutsche Pflanzengesellschaften. Fischer, Jena, DE.

Oberdorfer E (2001) Pflanzensoziologische Exkursionsflora. 8th ed. Ulmer, Stuttgart, DE.

Passarge H (1999) Pflanzengesellschaften Nordostdeutschlands II. Helocyperosa und Caespitosa. Gebrüder Borntraeger Verlagbuchhandlung, Berlin, Stuttgart, DE.

Peterka T, Hájková P, Jiroušek M, Hinterlang D, Chytrý M, Aunina L, Deme J, Lyons M, Seiler H, … Hájek M (2023) Formalised classification of the class Montio-Cardaminetea in Europe: towards a consistent typology of spring vegetation. Preslia 95: 347–383. https://doi.org/10.23855/preslia.2023.347

Ranđelović VN, Zlatković BK (2010) Flora i vegetacija Vlasinske visoravni. Univerzitet u Nišu, Niš, RS.

Raţiu O, Gergely I, Şuteu Ş, Marvu A (1983) Flora şi unităţile fitosintaxonomice de pe Valea Iadului (Jud. Nihor). Importanăa economică şi ştiinţifică. Caracterizarea lor ecologică II. Vegetaţia 1 [Flora and phytosyntaxonomic units of Valea Iadului valley (distr. Nihor). Economic and scientific importance. Ecological characterization II. Vegetation 1]. Contribuţii Botanicae 18: 69–97.

Redžić S (2007) Syntaxonomic diversity as an indicator of ecological diversity — case study Vranica Mts in the Central Bosnia. Biologia 62: 173–184. https://doi.org/10.2478/s11756-007-0026-3

Redžić S, Bulić Z, Hadžiablahović S (2011) High mountain vegetation of Dinarides (W. Balkan). Glasnik Republičkog zavoda za zaštitu prirode i Prirodnjačkog muzeja u Podgorici 31(32): 7–46.

Rennwald E (Ed.) (2000) Verzeichnis der Pflanzengesellschaften Deutschlands mit Synonymen und Formationseinteilung. Schriftenreihe für Vegetationskunde 35: 121–391.

Rivas-Martínez S, Fernández-González F, Loidi J, Lousã M, Penas A (2001) Syntaxonomical checklist of vascular plant communities of Spain and Portugal to association level. Itinera Geobotanica 14: 5–341.

Schaminée JHJ, Weeda EJ, Westhoff V (Eds) (1995) De vegetatie van Nederland. Deel 2. Plantengemeenschappen van wateren, moerassen en natte heiden. Opulus Press, Uppsala, SE.

Schaminée JHJ, Haveman R, Hommel PWFM, Janssen JAM, de Ronde I, Schipper PC, Weeda EJ, van Dort KW, Bal D (2017) Revisie vegetatie van Nederland. Westerlaan Publisher, Lichtenvoorde, NL.

Siebum MB, Schaminée JHJ, Weeda EJ (1995) Montio-Cardaminetea. In: Schaminée JHJ, Weeda EJ, Westhoff V (Eds) De Vegetatie van Nederland. Deel 2. Plantengemeenschappen van wateren, moerassen en natte heiden. Opulus Press, Uppsala, SE, 139–160.

Soó R (1949) Les associations végétales de la Moyenne-Transylvanie. II. Les associations des marais, des prairies et des steppes. Acta Geobotanica Hungarica 6: 3–107.

Theurillat J-P, Willner W, Fernández-González F, Bültmann H, Čarni A, Gigante D, Mucina L, Weber H (2021) International Code of Phytosociological Nomenclature. 4th edition. Applied Vegetation Science 24: e12491. https://doi.org/10.1111/avsc.12491

Tomaselli M, Spitale D, Petraglia A (2011) Phytosociological and ecological study of springs in Trentino (south-eastern Alps, Italy). Journal of Limnology 70(Suppl. 1): 23–53. https://doi.org/10.4081/jlimnol.2011.s1.23

Tüxen R (1937) Die Pflanzengesellschaften Nordwestdeutschlands. Mitteilungen der Floristisch-soziologischen Arbeitsgemeinschaft in Niedersachsen 3: 1–170.

Zechmeister H, Mucina L (1994) Vegetation of European springs: High-rank syntaxa of the *Montio-Cardaminetea*. Journal of Vegetation Science 5: 385–402. https://doi.org/10.2307/3235862

E-mail and ORCID

Michal Hájek (Corresponding author, hajek@sci.muni.cz), ORCID: https://orcid.org/0000-0002-5201-2682
Tomáš Peterka (peterkatomasek@seznam.cz), ORCID: https://orcid.org/0000-0001-5488-8365
Petra Hájková (buriana@sci.muni.cz), ORCID: https://orcid.org/0000-0003-1434-7825
Dirk Hinterlang (dirk.hinterlang@lanuv.nrw.de), ORCID: https://orcid.org/0000-0002-5434-1228
Harald Zechmeister (harald.zechmeister@univie.ac.at), ORCID: https://orcid.org/0000-0001-6578-7244
Milan Chytrý (chytry@sci.muni.cz), ORCID: https://orcid.org/0000-0002-8122-3075